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High-Sugar, High-Saturated-Fat Dietary Patterns Are Not Associated with Depressive Symptoms in Middle-Aged Adults in a Prospective Study

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Abstract

Background: The consumption of unhealthy "Western" dietary patterns has been previously associated with depressive symptoms in different populations.

Objective: We examined whether high-sugar and high-saturated-fat dietary patterns are associated with depressive symptoms over 5 y in a British cohort of men and women.

Methods: We used data from the Whitehall II study in 5044 individuals (aged 35–55 y). Diet was assessed at phase 7 (2003–2004) using a validated food-frequency questionnaire. Dietary patterns were derived by using reduced rank regression with sugar, saturated fat, and total fat as response variables. The Center for Epidemiological Studies–Depression (CES-D) scale was used to assess depressive symptoms (CES-D sum score ≥16 and/or use of antidepressant medication) at phase 7 and at phase 9 (2008–2009). We applied logistic regression analyses to test the association between dietary patterns and depressive symptoms. All analyses were stratified by sex.

Results: In total, 398 cases of recurrent and 295 cases of incident depressive symptoms were observed. We identified 2 dietary patterns: a combined high-sugar and high-saturated-fat (HSHF) and a high-sugar dietary pattern. No association was observed between the dietary patterns and either incidence of or recurrent depressive symptoms in men or women. For example, higher consumption of the HSHF dietary pattern was not associated with recurrent depressive symptoms in men (model 3, quartile 4: OR: 0.67; 95% CI: 0.36, 1.23; *P*-trend = 0.13) or in women (model 3, quartile 4: OR: 1.26; 95% CI: 0.58, 2.77; *P*-trend = 0.97).

Conclusion: Among middle-aged men and women living in the United Kingdom, dietary patterns containing high amounts of sugar and saturated fat are not associated with new onset or recurrence of depressive symptoms. *J Nutr* 2018;148:1598–1604.

Keywords: dietary patterns, depressive symptoms, sugar, fat, reduced rank regression

Introduction

"Western" dietary patterns are presumed to contribute to depression risk. Among others, inflammation has been postulated as a potential biological pathway (1). A suggested underlying mechanism for this pathway is that proinflammatory markers modulate the synthesis, release, and re-uptake of mood-related neurotransmitters (e.g., serotonin and dopamine) (2). However, evidence is still inconsistent for this relation because 2 previous prospective studies observed that Western dietary patterns were associated with a higher prevalence of depressive symptoms (3, 4), whereas 3 other prospective studies failed to find a significant association with new cases of clinically defined depression (5) and depressive symptoms (6, 7).

Western dietary patterns are characterized by high intakes of unhealthy snacks, fast foods, sugar-sweetened beverages, and red and processed meat, which generally contain high amounts of sugar and saturated fat. Previous prospective studies of the relation between the independent contribution of sugar and saturated fat to depression found that sugar intake [by studying sweet foods and beverages (8) and the glycemic index

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(9)] and saturated fat intake (10) were associated with higher depressive symptoms. However, it is difficult to determine the effect of single nutrients in examining diet-disease relations (11) because people consume dietary patterns that consist of complex combinations of nutrients that are highly correlated and interact with each other (12). Moreover, it is difficult to distinguish between a sugar and a saturated fat dietary pattern because many foods contain both macronutrients and the restriction of 1 macronutrient implies the increase of another macronutrient to maintain energy balance (13).

A previous study showed that a "combined high-sugar and saturated-fat" dietary pattern was associated with higher depressive symptoms and depressed mood in a multiethnic population by using reduced rank regression (RRR) (11). However, due to the cross-sectional nature of this study, reverse causation may have been present. In order to gain insight into this issue, the objective of the current study was to examine whether high-sugar and high-saturated fat (HSHF) dietary patterns are associated with depressive symptoms over 5 y in a British cohort of men and women. On the basis of findings from the aforementioned cross-sectional study and a previous study that observed a positive association between a "Western" diet and depressive symptoms in the same population (3), we hypothesized that an HSHF dietary pattern yielded from RRR would be associated with a higher incidence and recurrence of depressive symptoms.

Methods

Subjects and study design. The Whitehall II study is an ongoing cohort study conducted in London, United Kingdom, in 10,308 British civil servants aged 35–55 y. Baseline data collection (phase 1) took place in 1985–1988 and follow-up data on diet were collected in intervals of 5 y from 1991–1993 (phase 3) until 2016 (phase 12) and depressive symptoms from 2003–2004 (phase 7) onward. Participants completed a self-administered health questionnaire every 2–3 y and attended a health screening clinic for a clinical examination every 5 y. More detailed information concerning the study protocol can be found elsewhere (14). Complete data on diet, depressive symptoms, and demographic characteristics were available on 5044 participants at phase 7 and on 4515 participants for depressive symptoms at phase 9. The University College London Ethics Committee approved the study protocol, and written informed consent was obtained from all included participants after thorough explanation of the study. A flowchart of how the study sample was reached is given in **Supplemental Figure 1**.

Depressive symptom assessment at phase 7 and 9. The Center for Epidemiological Studies–Depression (CES-D) scale is a widely used self-report scale that measures depressive symptoms in the general population over the past week (15) and has been validated previously against an interviewer-administered instrument in an older population (16). CES-D data were administered at phase 7 (2003–2004) and 5 y later at phase 9 (2008–2009). Depressive symptoms were defined by a CES-D score ≥16, self-reported use of antidepressant medication, or both. Self-reported use of antidepressant medication was assessed by the following question: "Have you been taking any medicines, tablets, tonics or pills prescribed by a doctor (excluding contraceptive pills) within the last 14 days? If yes, please list any medicines below and the reasons for taking." In this study we defined 2 categories of depressive symptoms, as follows:

1) "Recurrent depressive symptoms": having depressive symptoms at both phase 7 and phase 9; participants with no recurrent depressive symptoms were described as not having depressive symptoms at phases 7 and 9 or when depressive symptoms occurred in only 1 of the 2 phases.
2) "Incident depressive symptoms": participants with depressive symptoms at phase 9, after exclusion of participants who were classified as having baseline depressive symptoms (CES-D score ≥16, self-reported use of anti-depressant medication, or both at phase 7) (17).

Dietary pattern assessment at phase 7. A machine-readable FFQ, which originates from the one used in the US Nurses' Health Study (18), was used to collect habitual dietary data and contained 127 food items. The FFQ was anglicized and foods commonly eaten in the United Kingdom were added (19). A common unit or portion size for each food (e.g., 1 egg or 1 slice of bread) was specified, and participants were asked how often, on average, they had consumed that amount of the item during the previous year. The 9 responses ranged from "never or less than once per month" to "six or more times per day". To derive nutrient intakes, the consumption frequency was multiplied for each food by its nutrient content and then summed across all foods. The FFQ has been previously validated in terms of nutrient and food consumption (19, 20).

We applied RRR to identify dietary patterns at phase 7. RRR derives dietary patterns in an exploratory way and is based on a priori knowledge in the selection of intermediate markers (response variables) that are thought to link dietary patterns to disease risk (21). Because we aimed to derive HSHF dietary patterns, we included the nutrients sugar (grams per day), SFAs (grams per day), and total FAs (grams per day) from the FFQ as response variables. All response variables were log-transformed because they were not normally distributed. In total, 34 food groups were created on the basis of nutrient profile and previous studies on dietary patterns and depression (**Supplemental Table 1**) (3, 11). All 34 food groups received a factor loading, but for simplicity, we reported only the food groups that loaded highly (≥0.20) and which we considered as being characteristic of the respective dietary pattern. We operationalized dietary pattern scores as quartiles on the basis of the whole population due to better distribution, with increasing quartiles representing higher intakes of the nutrients that are highly correlated to the dietary patterns and higher consumption of the foods that are characteristic for the dietary patterns. Quartiles were applied rather than a single cutoff because we were able to get insight into the trend of the association. This is important because a previous cohort study observed that the intake of dietary patterns may reach a threshold effect in relation to depression (22). More detailed information on RRR was described previously (23).

Covariates at phase 7. Models were adjusted for the following confounding factors in separate models at phase 7, which were determined a priori: age (in years), energy intake (kilocalories per day), ethnicity (white or nonwhite), educational level (low, middle, or high), marital status (married or cohabiting, single, divorced, or widowed), and socioeconomic status (SES) based on occupational position and categorized into 3 groups [high (administrative), intermediate (professional or executive), or low (clerical or support)]. This measure is a comprehensive marker of socioeconomic circumstances in the Whitehall II study being related to education, salary, social status, and level of responsibility at work (14). We further adjusted for physical

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Supplemental Figure 1 and Supplemental Table 1 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/jn/.
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Abbreviations used: CES-D, Center for Epidemiological Studies–Depression; HS, high-sugar; HSHF, high-sugar and high-saturated-fat; PAL, physical activity level; RRR, reduced rank regression; SES, socioeconomic status.

activity level (PAL) over the past year [active (>2.5 h/wk of moderate physical activity or >1 h/wk of vigorous physical activity), inactive (<1 h/wk of moderate physical activity and <1 h/wk of vigorous physical activity), or moderately active (if neither active nor inactive)], smoking status (never smoker, former smoker, or current smoker), coronary artery disease (denoted by clinically verified nonfatal myocardial infarction or definite angina), type 2 diabetes (defined by guidelines of the WHO), and BMI. Because alcohol consumption was included as one of the food components in our dietary patterns, we did not include alcohol as a covariate.

Statistical analysis. Baseline characteristics according to quartiles of the combined HSHF dietary pattern were explored by using the chi-square test for categorical variables (numbers and percentages) and the ANOVA test for continuous variables (means and SDs or medians and IQRs). Logistic regression models were applied to test the prospective association between quartiles of dietary patterns (with the first quartile being used as reference category) at phase 7 with incident depressive symptoms at phase 9 and recurrent depressive symptoms. In addition, tests for trend across the quartiles were calculated. To test whether the diet–depressive symptoms relation was similar for age and sex, we tested interactions between diet and age and diet and sex with regard to depressive symptoms in the fully adjusted regression models. We observed significant sex differences in the association between dietary patterns and depressive symptoms incidence and recurrence ($P < 0.20$) and therefore presented all models stratified by sex. No interaction was found for age. In the first model we adjusted for the demographic variables age, ethnicity, marital status, educational level, SES, and energy intake. In model 2, we additionally adjusted for the lifestyle variables smoking status and physical activity. Finally, we additionally adjusted for comorbidity (diabetes, coronary artery disease, and BMI) in model 3.

Sensitivity analyses. To examine whether the diet-depression relation was robust, we performed sensitivity analyses. First, we excluded participants with extreme energy intakes; underreporters were participants with an energy intake less than the basal metabolic rate × PAL, with PAL at a value of ≤0.87 h/wk, and overreporters were defined as those with an energy intake more than the basal metabolic rate × PAL, with PAL >2.75 h/wk (24, 25). Second, we included energy-adjusted food groups as predictor variables and repeated the dietary pattern analyses. Third, in addition to excluding participants with depressive symptoms at baseline, we additionally excluded participants with antidepressant medication use at phase 9 ($n = 73$) and repeated the analyses to distinguish between the questionnaire-based depressive symptoms and a physician's diagnosis. Furthermore, we repeated the analyses with severe depressive symptoms, defined as a CES-D score ≥23, self-reported use of antidepressant medication, or both to examine whether depressive symptom severity influences the association under study. Finally, we investigated extreme quartiles of the dietary pattern scores and depressive symptoms.

Results

Study population. Baseline characteristics according to quartiles of the HSHF dietary pattern are presented in Table 1. Participants in the highest quartile of the HSHF dietary pattern were mainly men, of white ethnicity, and had a higher SES. Furthermore, participants in the highest quartile were physically more active, smoked less, and had a higher energy intake. Finally, participants in the fourth quartile had more depressive symptoms and consumed more sugar, total fat, and saturated fat (Table 1).

Dietary pattern analysis. The food groups that were associated with the identified dietary patterns and their corresponding factor loadings are shown in Table 2. We identified 2 dietary patterns. The first dietary pattern was characterized by high intakes of sweet snacks, high-fat dairy products, fast foods, added sugar, butter, other fat, creamy sauces, processed meat, whole grains, and potatoes and was labeled as the HSHF dietary pattern. The pattern was highly correlated with all 3 response variables ($\rho = 0.74$, 0.88, and 0.87 for sugar, total fat, and saturated fat, respectively). The second identified dietary pattern was characterized by consumption of fruit, natural fruit juices, and low-fat dairy products, and to a lesser extent by added sugar and sugar-sweetened beverages, and was low in fatty foods (e.g., butter, red and processed meat, eggs, and fast foods) and was labeled as a "high-sugar" (HS) dietary pattern. Even though the food items of added sugar and sugar-sweetened beverages were below the cutoff of 0.20, they contributed to an important extent to this dietary pattern and are therefore presented. The HS dietary pattern was highly correlated with sugar ($\rho = 0.59$) and negatively correlated with fat and saturated fat ($\rho = -0.27$ and -0.24 for total fat and saturated fat, respectively). The explained variation in the response variables was 67% for the HSHF dietary pattern and 15% for the HS dietary pattern (15%) (Table 2).

Baseline dietary patterns in relation to recurrence of depressive symptoms over 5 y. Recurrent episodes of depressive symptoms were identified in 247 (7%) men and 151 (11%) women. The prospective association between quartiles of dietary patterns and the recurrence of depressive symptoms is presented in Table 3. No association was observed between higher consumption of the HSHF dietary pattern and recurrent depressive symptoms in men (model 1, quartile 4—OR: 0.63; 95% CI: 0.34, 1.16; *P*-trend = 0.087) or in women (model 1, quartile 4—OR: 1.26; 95% CI: 0.58, 2.73; *P*-trend = 0.988). The association did not change after additionally adjusting for lifestyle and comorbidity variables (men, model 3, quartile 4—OR: 0.67; 95% CI: 0.36, 1.23; *P*-trend = 0.130; women, model 3, quartile 4—OR: 1.26; 95% CI: 0.58, 2.77; *P*-trend = 0.973). Similarly, increasing quartiles of the HS dietary pattern was not associated with recurrent episodes of depressive symptoms in any of the models and this was similar in both sexes (fully adjusted model—men: *P*-trend = 0.069; women: *P*-trend = 0.579) (Table 3).

Dietary patterns and 5-y onset of depressive symptoms. We excluded participants with missing data on depressive symptoms at phase 9 ($n = 529$) and prevalent depressive symptoms at baseline ($n = 673$). This left us with 3842 participants for examining incidence of depressive symptoms. In Table 4 we present the prospective association between quartiles of dietary patterns at phase 7 and the incidence of depressive symptoms at phase 9. We observed 184 cases (6%) in men and 111 cases (10%) in women of incident depressive symptoms at phase 9. We did not find an association between increasing quartiles of the HSHF or the HS dietary patterns and incidence of depressive symptoms 5 y later in any of the models. For both men and women, in the fully adjusted model, being in the highest quartile of the HSHF dietary pattern was not associated with incident depressive symptoms 5 y later [OR (95% CI): 1.43 (0.71, 2.87); *P*-trend = 0.277; and OR: 0.73 (0.26, 2.06); *P*-trend = 0.590, for men and women, respectively]. Likewise, no association was found for higher consumption of the HS dietary pattern and incident depressive symptoms 5 y later in any of the models (model 3—men: *P*-trend = 0.687; women: *P*-trend = 0.907) (Table 4).

TABLE 1 Baseline characteristics according to quartiles of the combined high-sugar and high-saturated fat dietary pattern[1]

Characteristic	Quartile				*P*
	1 ($n = 1255$)	2 ($n = 1269$)	3 ($n = 1260$)	4 ($n = 1260$)	
Age, y	45 ± 5.7	44 ± 5.8	45 ± 6.0	45 ± 6.1	0.050
Women, *n* (%)	449 (36)	377 (30)	322 (26)	214 (17)	<0.001
Ethnicity, *n* (%)					<0.001
White	1094 (87)	1196 (94)	1210 (96)	1222 (97)	
Nonwhite	161 (13)	73 (5.8)	50 (4.0)	38 (3)	
Marital status, *n* (%)					0.001
Married or cohabiting	941 (75)	957 (75)	990 (79)	973 (77)	
Single	142 (11)	160 (13)	151 (12)	175 (14)	
Divorced, separated, or widowed	172 (14)	152 (12)	119 (9.4)	112 (8.9)	
Social economic status, *n* (%)					<0.001
Low occupation	152 (12)	105 (8.3)	104 (8.3)	88 (7.0)	
Middle occupation	591 (47)	549 (43)	526 (42)	505 (40)	
High occupation	512 (41)	615 (49)	630 (50)	667 (53)	
Physical activity, *n* (%)					<0.001
Inactive	374 (30)	293 (23)	306 (24)	262 (21)	
Moderately active	237 (19)	210 (17)	201 (16)	216 (17)	
Vigorous	644 (51)	766 (60)	753 (60)	782 (62)	
Smoking status, *n* (%)					0.018
Never smoker	581 (46)	591 (47)	628 (50)	652 (52)	
Former smoker	566 (45)	578 (46)	557 (44)	520 (41)	
Current smoker	108 (8.6)	100 (7.9)	75 (6.0)	88 (7.0)	
BMI, kg/m^2	27 ± 4.7	27 ± 4.2	27 ± 4.1	26 ± 4.0	0.085
Diabetes (yes), *n* (%)	315 (25)	282 (22)	324 (26)	295 (23)	0.154
CAD (yes), *n* (%)	125 (10)	112 (8.8)	100 (7.9)	117 (9.3)	0.344
CES-D score	8.4 ± 8.2	7.8 ± 7.3	7.4 ± 7.2	8.2 ± 7.7	0.002
Depressive symptoms (yes), *n* (%)	230 (18)	182 (14)	171 (14)	217 (17)	0.002
Recurrent depressive symptoms (yes), *n* (%)	108 (9)	89 (7)	85 (7)	116 (9)	0.058
Energy intake, kcal/d	1496 [291]	1941 [234]	2293 [253]	2984 [558]	<0.001
Alcohol intake, g/d	13 [13.8]	13 [14]	12 [13]	12 [13]	0.009
Monodisaccharide intake, g/d	91 [29]	118 [29]	143 [34]	184 [51.5]	<0.001
Total fat intake, g/d	48 [12]	67 [13]	82 [15]	115 [29]	<0.001
Saturated fat intake, g/d	24 [6.6]	33 [7.3]	41 [8.6]	59 [17]	<0.001

[1]Values are frequencies [*n*, (%)], medians [IQRs], or means ± SDs. CAD, coronary artery disease; CES-D, Center for Epidemiological Studies–Depression.

Sensitivity analyses. When excluding participants with extreme energy intakes ($n = 479$), no differences were observed for the association between the HSHF dietary pattern or with the HS dietary pattern and any depressive symptom category in either men or women. In a second sensitivity analysis, we repeated RRR with energy-adjusted food groups by using the residual method. We identified an HSHF dietary pattern with only butter, chocolates and sweets, high-fat dairy products, and added sugar as characteristic food groups. Consequently, this pattern was not associated with any depressive symptom category. We repeated analyses with severe depressive symptoms (CES-D score ≥23, self-reported use of antidepressant medication, or both), in which we observed no differences between any of the dietary patterns and any severe depressive symptom category as compared with the main analyses in either men or women (data not shown). Finally, we repeated the regression analyses by comparing extreme quartiles of the dietary patterns and observed that the highest quartile of the HS dietary pattern was significantly associated with recurrent depressive symptoms in men (quartile 4 compared with quartile 1—OR: 1.98; 95% CI: 1.28, 3.08; $P = 0.002$). For women, an initial significant association was found for the HSHF dietary pattern and recurrent depressive symptoms (quartile 4 compared with quartile 1—OR: 1.99; 95% CI: 1.20, 3.31; $P = 0.008$), but after additional adjustment for energy intake this association was largely attenuated.

Discussion

In this study, we identified 2 dietary patterns—an HSHF dietary pattern and an HS dietary pattern—and sought to examine their associations with the recurrence of depressive symptoms and new onset over a 5-y follow-up period separately in men and women. A higher consumption of dietary patterns high in sugar and saturated fat were not associated with the recurrence or incidence of depressive symptoms in men or women living in the United Kingdom.

Contrary to our findings, 2 previous studies observed an association between unhealthy "Western" dietary patterns and depressive symptoms (3, 4). Differences from the current study may be due to methodologic differences in deriving dietary patterns. These studies used principal components analysis to identify patterns, which is purely data driven (3, 4). Therefore,

TABLE 2 Food groups with their corresponding factor loadings derived by reduced rank regression[1]

	Load
Positive loadings	
HSHF dietary pattern	
Factor 1	
Chocolates, sweets, and pastries	0.44
High-fat dairy products	0.26
Fast foods	0.26
Added sugar	0.26
Butter	0.25
Other fat	0.21
Creamy sauces	0.21
Processed meat	0.20
Whole grains	0.20
Potatoes	0.20
HS dietary pattern	
Factor 2	
Fruit	0.58
Natural fruit juices	0.33
Low-fat dairy products	0.21
Added sugar	0.17
Sugar-sweetened beverages	0.12
Negative loadings	
HS dietary pattern	
Factor 2	
Butter	−0.29
Red meat	−0.23
Processed meat	−0.22
Eggs	−0.22
Fast foods	−0.22
Explained variation in response variables, %	
HSHF dietary pattern	67
HS dietary pattern	15

[1]The presented food groups with factor loadings of ≥0.20 were interpreted as being characteristic for the dietary patterns. HS, high-sugar; HSHF, high-sugar and high-saturated-fat.

TABLE 3 Prospective associations between quartiles of dietary patterns and recurrent episodes of depressive symptoms[1]

	Men ($n = 3344$)	Women ($n = 1171$)
HSHF dietary pattern		
Model 1		
Q1	1 (reference)	1 (reference)
Q2	0.83 (0.55, 1.25)	0.64 (0.39, 1.06)
Q3	0.66 (0.41, 1.05)	0.72 (0.40, 1.28)
Q4	0.63 (0.34, 1.16)	1.26 (0.58, 2.73)
P-trend	0.09	0.99
Model 2		
Q1	1 (reference)	1 (reference)
Q2	0.85 (0.56, 1.28)	0.66 (0.40, 1.09)
Q3	0.67 (0.42, 1.06)	0.71 (0.40, 1.27)
Q4	0.64 (0.34, 1.18)	1.24 (0.57, 2.71)
P-trend	0.09	0.96
Model 3		
Q1	1 (reference)	1 (reference)
Q2	0.86 (0.57, 1.29)	0.66 (0.40, 1.10)
Q3	0.69 (0.43, 1.10)	0.73 (0.41, 1.31)
Q4	0.67 (0.36, 1.23)	1.26 (0.58, 2.77)
P-trend	0.13	0.97
HS dietary pattern		
Model 1		
Q1	1 (reference)	1 (reference)
Q2	1.20 (0.83, 1.74)	1.07 (0.65, 1.77)
Q3	0.90 (0.61, 1.34)	0.87 (0.52, 1.46)
Q4	1.43 (0.99, 2.04)	0.88 (0.54, 1.43)
P-trend	0.16	0.46
Model 2		
Q1	1 (reference)	1 (reference)
Q2	1.21 (0.83, 1.74)	1.11 (0.67, 1.84)
Q3	0.93 (0.63, 1.38)	0.93 (0.55, 1.55)
Q4	1.50 (1.04, 2.15)	0.93 (0.57, 1.52)
P-trend	0.09	0.60
Model 3		
Q1	1 (reference)	1 (reference)
Q2	1.23 (0.85, 1.78)	1.11 (0.67, 1.84)
Q3	0.95 (0.64, 1.42)	0.91 (0.54, 1.53)
Q4	1.54 (1.07, 2.11)	0.93 (0.57, 1.51)
P-trend	0.07	0.58

[1]Values are ORs (95% CIs). Model 1 adjusted for age, ethnicity, marital status, social economic status, and energy intake; model 2 adjusted as for model 1 plus physical activity and smoking status; model 3 adjusted as for model 2 plus coronary artery disease, diabetes, and BMI. HS, high-sugar; HSHF, high-sugar and high-saturated-fat; Q, quartile.

although we identified a dietary pattern similar to those in Akbaraly et al. (3) and Le Port et al. (4), the most important food groups (chocolates, sweets and pastries, processed meat, high-fat dairy products, fast foods, and creamy sauces) in the current study (factor loadings of ∼0.25) contributed a lesser extent to the diet compared with the other studies (factor loadings of ∼0.40). Another potential explanation for the null findings may be due to the influence of energy intake. A previous prospective study observed that energy intake (partly) explained the association between unhealthy Western dietary patterns and depressive symptoms (6). For further insight into the influence of energy intake in the current study, we performed sensitivity analyses by excluding participants with extreme energy intakes and by repeating RRR with energy-adjusted food groups using the residual method. Neither of the analyses showed different findings from those of the main analyses. However, we did observe that the association between an HSHF dietary pattern and depressive symptoms was explained by energy intake in women when comparing extreme quartiles in sensitivity analyses, which indicates that energy intake may explain the null findings in women in the current study. Furthermore, when investigating the influence of other demographic or lifestyle variables in the current study, none of these variables could explain why we did not observe associations in the diet–depressive symptom relation. This is in contrast to 2 other prospective studies that observed initial positive associations between unhealthy dietary patterns and depressive symptoms, which were attenuated after adjustment for demographic and lifestyle variables (5, 7). A final explanation could be that the severity of depressive symptoms might have influenced the association under study. Therefore, we performed sensitivity analyses in which we examined the association between dietary patterns and severe depressive symptoms (CES-D score ≥23, self-reported use of antidepressant medication, or both). However, no differences in associations were observed. Thus, the severity did not influence the association between dietary patterns high in sugar and saturated fat and depressive symptoms.

TABLE 4 Prospective associations between quartiles of dietary patterns and incident episodes of depressive symptoms[1]

	Men ($n = 2910$)	Women ($n = 932$)
HSHF dietary pattern		
Model 1		
Q1	1 (reference)	1 (reference)
Q2	0.55 (0.33, 0.92)	0.71 (0.40, 1.25)
Q3	0.78 (0.45, 1.35)	0.81 (0.41, 1.60)
Q4	1.36 (0.68, 2.73)	0.69 (0.24, 1.93)
P-trend	0.34	0.52
Model 2		
Q1	1 (reference)	1 (reference)
Q2	0.55 (0.33, 0.92)	0.71 (0.40, 1.26)
Q3	0.79 (0.46, 1.36)	0.82 (0.41, 1.61)
Q4	1.38 (0.69, 2.78)	0.71 (0.25, 2.02)
P-trend	0.32	0.55
Model 3		
Q1	1 (reference)	1 (reference)
Q2	0.55 (0.33, 0.92)	0.72 (0.40, 1.28)
Q3	0.81 (0.47, 1.40)	0.83 (0.42, 1.65)
Q4	1.43 (0.71, 2.87)	0.73 (0.26, 2.06)
P-trend	0.28	0.59
HS dietary pattern		
Model 1		
Q1	1 (reference)	1 (reference)
Q2	1.43 (0.92, 2.21)	1.20 (0.66, 2.18)
Q3	1.55 (1.01, 2.38)	1.05 (0.57, 1.92)
Q4	1.01 (0.64, 1.60)	1.15 (0.64, 2.05)
P-trend	0.83	0.79
Model 2		
Q1	1 (reference)	1 (reference)
Q2	1.45 (0.93, 2.25)	1.16 (0.64, 2.12)
Q3	1.59 (1.04, 2.43)	1.01 (0.55, 1.87)
Q4	1.04 (0.66, 1.65)	1.09 (0.61, 1.96)
P-trend	0.71	0.92
Model 3		
Q1	1 (reference)	1 (reference)
Q2	1.45 (0.94, 2.26)	1.17 (0.64, 2.13)
Q3	1.61 (1.05, 2.47)	1.01 (0.54, 1.87)
Q4	1.05 (0.66, 1.67)	1.10 (0.61, 1.98)
P-trend	0.69	0.91

[1]Values are ORs (95% CIs). Model 1 adjusted for age, ethnicity, marital status, social economic status, and energy intake; model 2 adjusted as for model 1 plus physical activity and smoking status; model 3 adjusted as for model 2 plus coronary artery disease, diabetes, and BMI. HS, high-sugar; HSHF, high-sugar and high-saturated-fat; Q, quartile.

Our results also differ from those of a previous cross-sectional study performed in a multiethnic population residing in the Netherlands (11). The Dutch study observed that unhealthy dietary patterns, with consumption of foods that are rich in sugar and saturated fat, were associated with higher depressive symptoms, which persisted after correcting for energy intake. However, because these analyses were cross-sectional, reverse causation may have explained the association. Thus, in the current study, we excluded participants with depressive symptoms at baseline to examine the incidence of depressive symptoms. Furthermore, we additionally excluded participants with antidepressant medication use at follow-up (phase 9; $n = 73$) and repeated the analyses. However, no associations were observed for either of the dietary patterns. Therefore, it may be that in our previous cross-sectional study, the positive association between the HSHF dietary pattern and depressive symptoms was explained by reverse causality.

Our results concerning the HS dietary pattern are in line with our previous study in which a higher consumption of an HS dietary pattern was not associated with depressive symptoms (11), but are partly in contrast to a previous study conducted in the same population. Knüppel et al. (8) initially found that higher sugar intake from sweet food and beverages was prospectively associated with recurrent depression in men, but we only observed similar results in sensitivity analyses when comparing extreme quartiles. These different findings compared with our main analyses may be explained by the different method used, because Knüppel et al. specifically examined sugar intake, whereas the current study focused on the independent contribution of sugar as part of an overall dietary pattern. Moreover, the median fruit intake was very high (275 g/d) and was consequently characteristic of the HS dietary pattern due to the high amount of sugar in fruit. However, fruit intake has been indicated to lower depressive symptoms due to their antioxidant properties (26). It is possible that even though the sugar intake is high in the current population (for an important part from fruit), health benefits from fruit may have attenuated the association between the HS dietary pattern and depressive symptoms.

Strengths and limitations. The major strength of this study is the prospective design because we were able to examine the diet-depression relation longitudinally. The study was based on a large established cohort study with several points of follow-up, which allowed us to examine prevalence, incidence, and recurrence.

The major limitation of our study is the use of a self-reported, memory-based FFQ to collect dietary data. Data from an FFQ are subject to misreporting, depending on food group and weight status. Another limitation is the fact that people tend to underreport unhealthy foods, such as sweet snacks, sugar-sweetened beverages, and fast foods, and consequently, the observed associations are likely to be underestimates. Consequently, total energy intake is difficult to measure because it is also likely to be underestimated. In addition, we used a self-administered questionnaire to define depressive symptoms. Even though the CES-D has been validated previously in this population and was found to have a high sensitivity (89%) and specificity (86%), it may not be the best tool to examine new onset of depressive symptoms because the CES-D could be less sensitive for men in measuring depressive symptoms. Moreover, we did not use a clinical diagnosis (16). We tried to increase accuracy by including antidepressant intake in the definition. Finally, residual confounding may be present due to unknown or unmeasured lifestyle or demographic factors.

Conclusions. We found no evidence for an association of a dietary pattern high in fatty and sugary foods with incident and recurrent episodes of depressive symptoms in either men or women. On the basis of our results, we conclude that there is no consistent evidence for a relation between dietary patterns high in sugar and/or saturated fat and depressive symptoms. Further prospective studies are needed to disentangle the complex associations of the components of an unhealthy diet and the course of depression.

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